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ABSTRACT

This paper describes the use of portfolios to assess the preservice teacher's knowledge growth in teaching mathematics during a one year graduate-level teacher preparation program at Oregon State University. Portfolios provided evidence of what the preservice teacher used to show development of competency in knowledge and skill of teaching. Portfolio table of contents, scoring guide for work samples, and general scoring guide for grading the portfolio are presented. (ASK)

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# Formative and Summative Portfolio Assessment in a Preservice Secondary Mathematics Teacher Education Program

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Portfolios provide the opportunity for novice teachers to demonstrate what they "know and are able to do in a manner that reflects the complexity of teaching and showcases the integrated knowledge and skill of a competent teacher" (Collins, 1992). Can portfolios be used in the preparation of teachers to demonstrate their growth in their knowledge of and preparation for teaching? Can portfolio assessment provide both formative and summative evaluations of preservice mathematics teachers?

This paper describes the use of portfolios to assess the preservice teacher's knowledge growth in the teaching of mathematics during a one-year, graduate-level teacher preparation program at Oregon State University. This secondary mathematics teacher preparation program is guided by a conceptual framework described by Shulman (1986) as *Knowledge Growth in Teaching*, which emphasizes the integration of knowledge of schools, learners, curriculum, subject matter, and pedagogy with pedagogical content knowledge. Preservice student interns begin work on the Initial Licensure Portfolio at the beginning of the program in September. Throughout the year, individual pieces are graded and the interns are provided feedback in improving these pieces of evidence describing their understanding of the different domains of knowledge as well as the integration of the knowledge domains. The following June a summative assessment is made of the completed portfolio that includes the intern's essays about teaching and learning, two work samples with plans and reflections on units taught during the year, two video tapes of their teaching, and a video summary demonstrating their philosophy and skills.

## A Framework For The Preparation Of Mathematics Teachers

The overall organizational framework for Oregon State's preservice teacher preparation program is based on the *Knowledge Growth in Teaching* model (Shulman, 1986) with the ultimate focus on teachers as transformers of subject matter. The program focuses on the development, revision, and elaboration of six primary domains of knowledge that theory, research and practice have indicated are essential for effective instruction: subject matter knowledge, pedagogical knowledge, knowledge of schools, knowledge of learners, curricular knowledge, and pedagogical content knowledge. Pedagogical content knowledge is central to the model because it is the ultimate test of effective teaching, the teachers' ability to transform what he or she knows into a form that is accessible to learners. The belief is that with growth of these knowledge bases, the distinctions among them blur and the accumulation becomes the knowledge base for expert teachers. In other words, teachers are able to use the knowledge structures in an interrelated manner as they seek to address and confront the multiplicity of decisions they need to make in the preactive, interactive and post-active phases of teaching.

This conceptual framework for the program has been built primarily from a constructivist epistemology as a means by which the program focuses on the development of the abilities and skills that support future teachers in making informed and rational decisions when confronted with the many instructional decisions that arise in the classroom.

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Additionally, the research literature on effective teaching consistently informs the program and the experiences for these future teachers (e.g. Good & Brophy, 1997). Finally, students receive direct instruction on the nature and structure of mathematics, and are expected to utilize this knowledge when they develop and implement instructional activities in their field internship experiences.

**Teacher Preparation Coursework and Field Internship Experiences**

The teacher preparation program is an integrated one, with coursework and field internship experiences interspersed throughout. The complete program consists of three parts: (a) paraprofessional coursework including two field practica and three academic courses (Methods Foundations, Math Lab and Materials, and Teaching Math with Technology) taken prior to the internship year, (b) an academic year leading to the initial (beginning) teacher license, and (c) 18 quarter credits leading to the continuing teacher license and the Master of Science degree in Mathematics Education.

The initial licensure program is designed for the students to examine their initial pedagogical beliefs, gain insight into the influences that have shaped their beliefs, acquire knowledge of classical and contemporary pedagogical perspectives, and examine the viability of alternative perspectives. The primary objective guiding the development of the program toward these purposes is to support the development of professional knowledge ability and competence essential to successful teaching, specifically that expands their knowledge of learners, schools, subject matter, pedagogy and pedagogical content. Based on this understanding, a carefully planned sequence of courses and internships is provided.

Overall, the courses are divided into three areas: analysis of classrooms, mathematics methods and pedagogy coursework (Methods I, II, and III; Pedagogy I, and II), and field experiences (internships). Knowledge of schools and knowledge of learners are primarily addressed in the analysis sequence. Knowledge of subject matter is primarily dealt with in the nine graduate hours of graduate level subject matter students are required to complete in addition to the subject matter included in their bachelor's degree. The primary focus of the mathematics methods and pedagogy is upon curriculum, pedagogy and pedagogical content knowledge. The program specifically addresses the development of pedagogical content knowledge in the Mathematics Pedagogy courses taught winter and spring terms.

The primary focus of the field experiences is upon the integration of all six domains of knowledge, for it is that integration that is required for successful teaching. Early in the program, the students are prepared as researchers through an emphasis on observation, reflection and the development of a repertoire of observation skills during their field experiences. Students conduct mini-research projects that require both quantitative and qualitative techniques. Through this research, they investigate the complexity of the classroom, how the teacher notices that complexity, and how the teacher guides learning in that complex environment (Good & Brophy, 1994). Students learn to be good observers, well-versed in research on teaching, and learn the necessary skills to actually plan and implement action research in their own classrooms.

The first field experience begins with the beginning of the public school teacher inservice program where the interns spend full days in the setting working with their mentor teachers' classes. They are expected to participate in general school activities such as faculty and department/team meetings, inservice activities, parents' night, and other activities deemed relevant by the mentor teacher. Interns also participate in school

professional activities such as determining classroom management policies, interviewing counselors and administrators and classified personnel, and observing students and teachers at work. Finally, students are introduced to the varied responsibilities of teaching. They begin by observing and assisting, then gradually integrate into teaching.

The major Fall teaching experience takes place in November, when students teach a unit plan that has been planned during October. Students complete a 12-week full time internship at a second school site in the Winter/Spring followed by 6 weeks of part-time experiences in the classroom. The purpose of the internships are to develop: classroom management skills, teaching skills with a variety of teaching methods and strategies, diagnostic and evaluative skills, understanding of the mathematics curriculum and the structure of mathematics, understanding the role of research and application of its results in the classroom, of adolescents and their diversity, and basic problems and concerns of the teaching profession.

## The Portfolio

The Initial License Portfolio is an accumulation of evidence to indicate the growth in the knowledge and skills in teaching by the mathematics preservice teacher. The portfolio is an indication of the quality of work of which the prospective teacher is capable. The portfolio includes work samples, videotapes of teaching, a video summary, several essays, and materials documenting professional activity in mathematics education. Additionally, the content of the portfolio includes revised papers and projects completed during the internship year that students choose to exemplify their growth in knowledge of subject matter, pedagogy, secondary school students, curriculum, schools, and pedagogical content knowledge. Table 1 provides a summary description of the 1999-2000 Portfolio Table of Contents.

### Development of the Work Samples with Video Tapes

Students are required to complete Work Samples for two school levels of licensure authorization. Typically, students choose middle school and high school as the two levels. The Work Sample documents the intern's planning, instruction and assessment skills in teaching a two-to-three week unit. Evidence of the intern's work includes the complete unit lesson and assessment plans, videotapes of teaching, daily reflections, and an analysis of student learning, quality of assessment instruments, and their own instruction. One Work Sample is required in the Fall and one in the Winter/Spring internships.

In September student interns, with the help of mentors and supervisors, identify a small unit to be taught in November/December. When Methods I course meets in October, student interns develop their teaching plans for this unit. At each step of the Work Sample development, students get feedback from their professors, supervisors, mentors, as well as peers, in order to maximize the probability of success when teaching the unit.

The development of the Fall Work Sample is done in small increments. First, students do research on their topic by becoming knowledgeable about the text and other resources such as NCTM's Addenda Series, the Web, and Teaching Mathematics at the Middle School. They then develop a collection of teaching ideas on their topic from the mathematics teaching literature. Additionally, they need to make certain they understand their topic in a deep and connected way. Second, students develop a rationale for teaching their topic and outline the subject matter they expect to teach. Third, students develop overarching goals using NCTM's Curriculum Standards (1989) and the State of Oregon's

Benchmarks, instructional objectives, and a teaching outline or calendar of activities by day. Fourth, students write lesson plans and assessment plans. All of these segments are assessed so that students can make revisions.

In November, student interns return to the classroom to begin teaching the unit they have developed. After teaching some individual lessons assigned by the mentor teacher, the student interns have the opportunity to teach the unit they have prepared during October. The student interns teach each lesson, then reflect on what did and did not work. While they are teaching, they receive advice from mentors and supervisors on a regular basis, and revise plans as needed. Student interns are also responsible for assessing their students during and at the conclusion of the unit instruction. Upon completion of their teaching, the student interns polish the presentation of all the pieces into the Work Sample I and prepare an analysis of (1) student learning, (2) the assessment tools and (3) their own instruction and growth as a teacher.

In preparation for Winter term, the student interns spend one fulltime week during December at their second school site. They become familiar with the school, the mathematics department, and their mentor teacher's classes. During this time, the intern, mentor, and supervisor develop a schedule for the Winter/Spring fulltime internship. Also, units that the intern will be teaching are identified. One of these units is eventually developed for Work Sample II in the same manner as Work Sample I.

In January, interns take classes to prepare for their fulltime teaching assignment. Methods II and Mathematics Pedagogy I assist students in researching the topics they will be teaching and planning for their assigned units. At this point, the Methods course focuses on traditional and authentic assessment. Interns develop an assessment plan that includes a test and some authentic/alternative assessment. It is expected that Work Sample II will include a more thorough assessment and evaluation plan and that the intern will be able to demonstrate skills in assessing students and learning more thoroughly than in Work Sample I. Mathematics Pedagogy I deal with specific topics that the interns will eventually teach; during this course, they explore a variety of possible approaches with expected student outcomes.

During the fulltime internship, interns are expected to teach approximately a half of a teacher's instructional load with two different preparations over a 12-week period. They are expected to keep a planning book of all lesson plans (organized in units) and to periodically videotape their instruction. University supervisors conduct clinical observations at least seven times over the 12 weeks. Work Sample II is taught during the middle of the experience after interns have established classroom management routines.

**Reflections for the Portfolio: Essays and Video Summary**

A variety of additional artifacts are developed throughout the program. The intern's philosophy of education is documented prior to, during and following the fulltime internship. The intern's initial experience in writing their philosophy of education usually comes with a writing sample in their application to the program. Their second attempt is during Methods/Foundations during the summer prior to the Initial Licensure program where one of the course objectives is to learn about different philosophical positions and how these positions have developed throughout different historical periods in US education. These two writing pieces are usually quite different, the first more idealistic and the second more academic. The third writing of their philosophy takes place in the Winter Methods II course, prior to beginning the fulltime internship at their second school site. This writing piece often includes parts of the previous two, but tends to be much more practical. The assignment for this writing identifies specific areas for

inclusion: the nature of mathematics, what is worth knowing in mathematics, how is this knowledge reflected in the curriculum, how do students learn best and how should it be taught. Their philosophy is given feedback by professors. After the fulltime internship is completed, the interns rewrite their philosophy, reflecting on their changes in perspectives as they have assumed full instructional responsibilities.

The interns' videotape summaries, prepared during May, reflect their philosophy of education as well as their developing knowledge and skill in teaching. Video clips of their work exemplifying their philosophy and teaching are interwoven with their stated philosophy. The last day of classes includes "showtime" when the video summaries are shared with the other interns. Video summaries are assessed on both the content and the production.

Interns write six essays to reflect their Knowledge Growth in Teaching specifically with respect to the different domains of knowledge: subject matter; learners; curriculum; schools; pedagogy; and pedagogical content knowledge. They also provide evidence through other work they have produced (other than the work samples) to substantiate the claims they make in their essays. For example, in the pedagogy essay, interns discuss their skill in classroom management, lesson planning, teaching methods and strategies, questioning and wait time. This essay tends to be the best essay students write, since they have not had enough experience to reflect much growth in pedagogical content knowledge. Preservice teachers have a better understanding of how students learn and the diversity of student learners after their internships, but they generally can not talk about student needs in terms of individuals at this point in their growth as teachers. Artifacts, such as specific lessons, classroom management plans, are also referenced in their essays to provide evidence for their claims made in the essays.

**Summative Evaluation of Interns From Portfolio Evidence**

While portfolio development includes advice, feedback, and revision (formative evaluation) throughout the internship year, summative evaluation takes place at the end of each term. The work samples and videotapes are graded by the interns' supervisors. Scoring guides for the work samples and the portfolio have been developed (see Tables 2 and 3); grading sessions are held with the supervisors to discuss the use of the guides. Group grading sessions provide a reliability check for those grades below a B or for borderline grades (an A- or B+). In these cases, a second professor reads key elements in the portfolio, watches videotapes if relevant, and checks the written description the supervisor has written. If evaluations differ, a discussion of the scoring guide interpretation takes place and a final grade is determined.

The Work Sample drafts are graded as part of the internship grade each term. They also add to the conversation about whether a student has progressed enough toward program benchmarks for continuing in the program. The faculty consider supervisor and mentor recommendations, grades in courses, and progress toward the Benchmarks, as well as Work Sample success, in making the decision to support a student in proceeding to the next level of the program. The decision to place the student on a plan of assistance to remediate difficulties or to provide additional time to gain required competency may also be made.

At the end of the year, the Initial Licensure Portfolio is a major piece of evidence of the student intern's readiness for beginning teaching. As with each term, however, the intern's grades in the courses and recommendations form supervisors and mentors are important considerations. As required by the state licensing agency, the completed

portfolio is maintained on file for five years as evidence of the teacher's preparation. If a teacher is having difficulty in the first years of teaching, the licensing agency may request to review the work to identify whether the problems were evident during the program.

**Discussion**

The Initial Licensure Portfolio provides another piece of evidence that the preservice teacher uses to show development of competency in knowledge and skill of teaching. As formative assessments the portfolio provides opportunities to plan, teach, reflect, get advice from mentors and supervisors, then do more planning. As summative assessment, the student completes the portfolio, as required by the State and the University, and finally presents the portfolio as part of his or her project at the oral defense for the Master of Science Degree. The student spends a lot of time reflecting on the work and problem solving difficulties encountered while going through this process. This reflection provides opportunities and develops habits of mind, which allow the new teacher to continue to learn about teaching throughout the teacher's career.

On the other hand, one student said, "I spend so much time writing my reflections, I rarely 'really' reflect deeply." Other students do not really understand how to reflect about their work, and do so at a surface level. Supervisors work with students to develop these skills. Occasionally, a supervisor reports that interns' reflection from lessons that were supervised do not match with the reality the supervisor saw. Is the intern bending reality to suit his/her needs, or does he/she really not have a good idea of what is going on in the classroom? A worse difficulty occurs when students write well and deliver a credible portfolio, but do not make required growth in the classroom. This reason supports the multiple assessment model we have adopted – clinical supervision visits, supervisor meetings, meetings with mentors, videotapes, and the videotape summary. Alternatively, a student might not be a good writer, and not be able to represent his or her work adequately in the portfolio. This situation likewise recommends a multiple assessment model. A final problem creeps up for some students. Some interns hold the misconception that the intersection of the work done for the Work Sample and any other teaching unit is small. Some believe that planning for one lesson at a time is the best model for any unit plan not being used as a Work Sample. Some mentors also find the detailed planning that is required as onerous and perhaps superfluous. Supervisors, mentors, and students work toward consensus based on individual intern needs as far as detailed planning is concerned. The "proof is in the pudding," meaning that what interns are able to accomplish with students in their classes is the primary evidence, and the help they need to support student success for the majority of their mathematics students is the goal.

All-in–all, the pros outweigh the cons of portfolio development, primarily because of the resources provided in the program: ongoing clinical supervision, ongoing feedback from professors, supervisors, mentors, and peers. The final portfolio is usually the source of great pride for the new teachers. The last day of classes is, of course, a celebration of attainment, as well as successful completion of a rigorous teacher education program. For the majority of new teachers, the portfolio represents their beliefs and philosophy, their growth in the knowledge and skill of teaching, and their competence and ability to plan, teach, assess, and reflect in a way that will serve them well as they begin their first teaching position.

**References**

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Good, T. L., & Brophy, J. E. (1997) *Looking in classrooms*. New York, NY: Longman.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15, 4-14.

**Table 1.** 1999-2000 Portfolio Table of Contents

1. **Title page**
2. **Professional Resume**
3. **Introduction/overview** explaining the contents and organization of the portfolio
4. **Table of Contents** for the portfolio, including the videos; include page numbers.
5. **Philosophy of Teaching Mathematics**
5. **Subject matter knowledge.** This section describes growth in knowledge of foundational ideas and conceptual schemes, data, and procedures within your specific subject matter area. The nature of your subject matter must be well represented
6. **Domains of Knowledge**
   - **6.1 Pedagogical knowledge.** This section describes growth in knowledge of broad principles and strategies of classroom instruction and management that transcend subject matter.
   - **6.2 Knowledge of schools.** This section describes growth in knowledge of educational contexts, ranging from the place of the classroom in the school to the school in the community and other social contexts (including legal expectations for schools).
   - **6.3 Knowledge of learners**. This section describes growth in knowledge of relevant aspects of intellectual, social, and emotional development of your students. Include both how learners are similar and how they are different.
   - **6.4 Knowledge of the curriculum**. This section describes growth in knowledge of the development and implementation of programs and materials designed to support instruction.
   - **6.5 Pedagogical content knowledge**. This section describes growth in knowledge of representing and formulating subject matter knowledge that make it comprehensible to others (knowledge of how to transform and represent subject matter so that it is comprehensible to students or others). This section is the specific professional knowledge of mathematics and science teachers that demonstrates planning, implementation and reflection.
7. **Conclusion**. A concluding statement "tying" the portfolio together.
8. **Appendices**
   - A. Work Sample One
   - B. Work Sample Two
   - C. Videotapes of lessons (minimum of two complete lessons from different units designed and taught)
   - D. Video Summary
   - E. Additional pieces of evidence that are referred to often and not placed as pieces of evidence within specific sections. Limit these pieces of evidence to a maximum of two or three best pieces.

**Table 2. Scoring Guide for Work Samples**

The **A** work sample is exciting to look through.

- It includes a variety of approaches to teaching/learning and assessment.
- Strong match between goals, objectives, lessons, assessment that includes NOS/NOM or inquiry/problem solving
- There is evidence of the use of many resources, other than "textbook" driven.
- The work sample communicates clearly.
- Provides evidence of original thinking as well as reflective thinking.
- Evidence of action with plan for self-evaluation (comments at end of each lesson are an indication, as well as attention to future uses of the plans).
- Evidence of reflection about the success of instruction is provided through pupil data summarized in relation to pupils' level of knowledge prior to instruction, interpretation and explanation of assessment data, and description of how the data can be used in planning and implementing future instruction. Thoughtful and insightful.
- Attention to feedback provided during the term is integrated throughout the work-sample.

The **B** work sample indicates a solid approach to the unit.

- A variety of approaches are evident.
- Good match between goals, objectives, lessons, assessment
- Clarity of communication is evidenced in each section and each section has been considered.
- Attention to analysis of teaching section by providing pupil data and interpretation of results.
- Reflection on teaching/learning throughout the unit (e.g., evidence of reflection on ways to improve the instruction), or evidence on student progress is usually completed.
- Reflection on the last two sections is generally adequate.
- Attention to feedback provided during the term is generally used in preparation of the worksample.

The **C** work sample indicates an approach to the unit that is inadequate in some of its elements. (The work sample must be revised and resubmitted for approval.)

- Little evidence of a variety of approaches
- Lack of match between goals, objectives, lessons, assessment. NOS/NOM or inquiry is weak or not evident.
- Clarity of communication is not always evidenced in each section, some sections are inadequate.
- Attention to analysis of teaching section by providing pupil data and interpretation of results is weak.
- Factors missing may be consistent reflection on teaching/learning throughout the unit (e.g., evidence of reflection on ways to improve the instruction), or evidence on student progress.
- Reflection is not strong in the last two sections.
- Little attention to feedback provided during the term is evident.

**Table 3. General Scoring Guide for Grading the Portfolio**

The **A** portfolio is an exceptional demonstration of the intern's professional growth expected by the end of the Winter term internship. All requirements of the portfolio are provided in a professional manner demonstrating consistent evidence of the integration of the domains. The portfolio provides evidence of original thinking as well as reflective thinking with respect to the organizational framework, *knowledge growth in teaching*. Good attention to the incorporation of a variety of evidence that is presented in a professional manner.

The **B** portfolio is a good demonstration of the intern's professional growth expected by the end of the Winter term internship. Every required section of the portfolio is presented in a professional manner providing some evidence of the integration of the domains. Reflection not as strong as in top level but does demonstrate that the intern has reflected on the importance of the six domains.

The **C** portfolio has some sections inadequately presented although some attention has been given to each section. Limited reflection is present. Evidence of integration of the domains is not present.

The *poorly prepared* portfolio is incomplete, lacking evidence and/or reflection. There is almost no evidence of original thinking or consideration of the different sections of the portfolio.